TEJAS Journal of Technologies and Humanitarian Science
ISSN-2583-5599
Vol.03, I.02 (2024)
https://www.tejasjournals.com/

A COMPREHENSIVE EXAMINATION OF SUPPLY CHAIN APPLICATIONS INTEGRATING BLOCKCHAIN TECHNOLOGY AND ARTIFICIAL INTELLIGENCE

Mr. Rinku Raheja[1], **Mr. Mahesh Tiwari**[2], **Manas Mehrotra**[3] and **Ayush Kumar**[4]

[1]Assistant professor, Department of Computer Science, NPGC, Lucknow, India
[2]Assistant professor, Department of Computer Science, NPGC, Lucknow, India
[3]Student, Scholar, Department of Computer Science, NPGC, Lucknow, India
[4] Student, Scholar, Department of Computer Science, NPGC, Lucknow, India

KEYWORD

Blockchain, Artificial intelligence, Supply chain, Methodical literature review, Bibliometric review, Thematic analysis

ABSTRACT

The admixture of blockchain technology and artificial intelligence(AI) has garnered significant interest in recent times, primarily due to the eventuality for enhancing the security, efficacity, and productivity of operations within business settings that are marked by oscillations, unpredictability, intricacy, and vagueness. Supply chains, in particular, have been demonstrated to gain a great deal from blockchain and artificial intelligence. These technologies ameliorate information and process adaptability, grease briskly and more provident product delivery, and increase product traceability, to name a many benefits. This exploration does a slice- edge force chain analysis of blockchain and artificial intelligence. More precisely, we aimed to respond to the following three main queries Q1 What studies are now available on the integration of blockchain and artificial intelligence in force chains? Q2 What use cases for blockchain and AI are presently being delved in force chains? Q3 What avenues of exploration could be pursued in the future for studies involving the integration of blockchain and AI? Through the integration of blockchain and artificial intelligence, this paper's analysis has linked material exploration works that have conceptually and empirically contributed to the growth and accumulation of intellectual value in the force chain discipline.

1. Introduction

Supply chains have historically been geographically fractured and grueling to manage. multitudinous rudiments contribute to the complexity of the force chain, and among other effects, effective operations operation, conservation, and form are essential to its long- term sustainability. assessing information and controlling threat in force chain networks is a grueling bid because of colorful factors similar as mortal geste, artistic morals, and nonsupervisory rules, in addition to connection conservation(Ivanov etal., 2019). Ineffective force chains, fraud, theft, and hamstrung deals can each snappily erode trust, which emphasises the significance of advanced information sharing and verifiability(Saberi etal., 2019). Traceability is getting a competitive advantage in numerous force chain businesses and a need in moment's profitable terrain. In the absence of force chain translucency, stakeholders are unfit to directly determine and corroborate the factual worth of the products. Managing force chain traceability becomes indeed more grueling due to the cost and trustability of working with interceders, which can beget competitive challenges with character and strategy(Saberi etal., 2019). Because ultramodern force chains calculate so largely on centralised, sometimes disconnected, and standalone information operation systems — like enterprise resource planning systems — they have a number of problems(Saberi etal.,

Corresponding Author: Mr. Rinku Raheja, Assistant Professor, National P.G. College, Lucknow, India
Email: manasmehrotra1307@gmail.com

2019). One disadvantage of centralised information systems is that they've a single point of failure, which leaves the system open to miscalculations, hacking, corruption, and other forms of assault(Dong etal., 2017). For force chain realities to transfer their important and sensitive data to a single organisation or broker, there must be a high degree of trust present(Abeyratne & Monfared, 2016). likewise, force chain practices are under constant demand to admit and certify force chains' sustainability. As part of the triadic- bottom- line idea, environmental, social, and business enterprises must all be taken into account to achieve sustainability(Seuring etal., 2008). Supply chain sustainability is a strategic and competitive issue that necessitates validating and vindicating that force chain conditioning, products, and processes meet specific sustainability instruments and norms(Grimm etal., 2016).

It's necessary to assess if current force chain information systems are suitable to deliver the safe, transparent, and secure data needed to cover the timely origin of goods and services. Enhancing force chain security, translucency, long- term profitability, and process integrity are essential to prostrating these grueling issues. Blockchain technology may be suitable to help with this issue. These pretensions are now more accessible from an organisational, technological, and fiscal perspective thanks to recent inventions and operations erected on the blockchain conception(Abeyratne & Monfared, 2016). Blockchain technology can enable global- scale sale and process disintermediation and decentralisation across a range of colorful stakeholders thanks to its decentralised," unsure" database features(Crosby etal., 2016; Saberi etal., 2019). Although the number of blockchain use cases has increased over time, force chain networks still face a variety of obstacles and hurdles when it comes to espousing and enforcing blockchain, just like they do with any other potentially disruptive system or technology, as observed by Saberi etal.(2019). Since blockchain technology is still in its immaturity, it presents a variety of organisational, technological, behavioural, and policy- related enterprises. AI holds the implicit to address several of the forenamed issues. Actually, it's anticipated that combining blockchain technology with artificial intelligence would affect in a variety of noteworthy benefits, including further dependable deliverables(Odekanle etal., 2022). Through this kind of integration, parties can change enormous volumes of data for analysis, education, and decision- making without counting on a central authority or outside intercessors.

The force chain may be fully redesigned by utilising AI technology in the blockchain system to automate the entire process. In order to identify data characteristics and carry out prophetic analysis tasks like unborn demand and deals soothsaying, precious information can be uprooted from literal purchase data and other sources using a combined AI and blockchain approach(Zhang etal., 2021a, b). Because of this, the thing is to not only examine the current status of exploration on the integration of both technologies, but also to demonstrate how this integration has the implicit to fully transfigure force chain operation" business as usual." Through the integration of blockchain and artificial intelligence, this paper's analysis has linked material exploration works that have conceptually and empirically contributed to the growth and accumulation of intellectual value in the force chain discipline. As we shall demonstrate, utmost of the material is abstract in character rather than empirical, suggesting that the combination of blockchain and AI is still in its immaturity. still, it's anticipated that this study will help academics, interpreters, and policymakers understand the state- of- the- art in the field and support their decision-making to engage in empirical studies fastening on the factual deployment of AI- driven blockchain technology for force chains and its counteraccusations for long- term performance. This will be fulfilled by pressing current trends and interests in the field. therefore, the present work will act as a base for coming examinations.

2. Blockchain and Artificial Intelligence as a theoritical foundation for Supply Chains

The force chain includes all conduct related to the manufacture of goods and the distribution of finished particulars, from the procurement stage to the product stage. Alternately, as described by Pimenidis etal.(2021)," A force chain is the process of the inflow of goods from the upper situations of value creation to the end client consumption in the manufacturing realm." It's a type of mutually salutary relationship where suppliers and guests purchase, transfigure, distribute, and vend goods and services to produce particular end products and to enhance the value of their separate businesses(p. 369). In this way, the force chain has a complex armature that's the foundation for a large quantum of commercial productivity and profitability, anyhow of assiduity. Supply chains can not serve well without secure, effective, and effective information sharing. Effectiveness, openness, and

confidence among stakeholders are necessary for a successful force chain at every stage of the process. likewise, for force chains to be sustainable, they need to come more flexible and traceable in addition to being more flexible and adaptive. Once further, technology and invention will be essential to the success of the force chain(Baucherel, 2018). In this regard, blockchain has come a vital technology that could enhance the rigidity and dexterity of force chain operations(Cole etal., 2019). All ecosystem actors can laboriously interact, exchange, and validate any kind of data and information by utilising blockchain technology(Gohil & Thakker, 2021).

It's said that Satoshi Nakamoto is the one who first conceptualised" blockchain." In a paper released in 2008, Nakamoto(2008) introduced the idea of the first peer- to- peer electronic cash system supported by digital plutocrat, which came to be known as" bit- coin." Blocks that are connected to one another are used to record deals. The word" blockchain" then refers to a network of affiliated deals. Blockchain reduces legal and sale costs by allowing nonnatives to distribute safely without the demand for a centrally trusted middleman(Pilkington, 2016). Because records can be kept in multitudinous locales and participated with different parties, the term" distributed tally" was chased. To put it another way, blockchain technology is a distributed, decentralised database of records or participated public/ private digital tally that's used to record performed deals and participated between agents that are a member of the network(Crosby etal., 2016). Blockchain technology differs from utmost current information system designs because to four main features smart prosecution, security, auditability, andnon-localization(decentralisation)(Saberi etal., 2019; Steiner & Baker, 2015). A blockchain agent initiates a new sale to be added to the blockchain, which is how the blockchain operates. After entering blessing from the maturity of bumps, this new sale is transferred to the network for auditing and put to the chain as a new block. For security purposes, it's also kept among multiple dispersed bumps. One of the main factors of blockchain technology is the smart contract, which enables dependable deals to be carried out without the need for a third party. Hence, among the numerous benefits of blockchain technology are real- time force chain visibility and a dropped chance of fraud and data tampering(Cottrill, 2018; Partida, 2018).

Rodríguez- Espíndola etal.(2020) have linked some significant aspects of this technology that make it a precious proposition to manage deals:

1. **Immutable:** Every sale will be shielded against erasure, revision, and correction by the blockchain, which will record and keep all of the deals. Any variations are automatically recorded by the software law in the blocks as new deals that are connected to the before sale.
2. **Distributed:** Every member of the blockchain network(occasionally appertained to as a" knot") has an identical dupe of the tally on their PC. This increases visibility, making cash operation and the people engaged in the sale easier to identify.
3. **Decentralised:** This point makes deals between blockchain network realities simpler by doing down with the demand for a mediator and expediting processing times.
4. **Automated:** To guarantee sale authenticity, the blockchain's programming automatically logs and cryptographically validates each sale. This makes the entire procedure error-free and impervious to corruption. The robotization leads to shorter sale times.
5. **A single unchangeable ledger:** It'll be simpler to aggregate deals together if a permissionless blockchain network is utilised and every sale is proved in a single, incommutable public tally.
6. **Self-reviewing:** Every time a sale takes place, the blockchain automatically updates and logs the data, making sure that each knot(network stoner) has access to the most recent interpretation of the tally.

Artificial Intelligence(AI) is a field that studies how to make a machine or programme do tasks that a human would generally negotiate; as similar, AI is used to produce intelligent computers and machines that parade mortal-suchlike geste . AI comes in two flavours general AI and narrow AI. The most common kind of AI available moment is still narrow AI, or AI algorithms designed to attack a single task or problem. Again, general artificial intelligence(AI), which is defined as an AI programme that can answer any problem presented to it, is still in its early stages of development.

Blockchain technology can help the force chain in a number of ways when combined with AI. The result to guarding the operations of a original or indigenous force chain and offering the intelligence demanded to ameliorate functional efficacity may lie in a force chain driven by blockchain and artificial intelligence(Pimenidis etal., 2021). It can help make wise opinions and ameliorate data security and effectiveness(Banerjee etal., 2018). Large volumes of data are safely stored by blockchain, and artificial intelligence(AI) creates new scripts and patterns grounded on the geste of data and assists in data analysis and perceptivity(Ahmed etal., 2022). Blockchain and AI algorithms can enable force chains come more responsive, flexible, and effective while also conserving sale translucency for

the advantage of all actors(Pimenidis etal., 2021). Overall, operations may be made more reliable, secure, transparent, and secure by integrating blockchain technology and AI. To the stylish of our knowledge, studies on the operation of AI and blockchain in force chains have been published; still, these studies have generally addressed the two technologies singly, as though they were at different ends of a continuum. In discrepancy, the integration of the two sundries is examined in the current work.

3. Methods and Materials

3.1. Extracting relevant literature

We conducted a intensive consider of the writing in arrange to reply our investigate questions. The primary scientific database utilized to attain this objective was the Scopus look database, which is Elsevier's abstract and quotation database. For writing mapping, Scopus could be a well-known and prevalent apparatus (e.g., Fahimnia et al., 2019). Scopus was chosen as one of the most excellent conceivable outcomes in spite of the accessibility of other databases due to its exactness in finding creators and teach and its consistent citation measurements (Charles et al., 2022a, b). Moreover, concurring to Martín-Martín et al. (2018), Scopus offers a more exhaustive coverage of papers within the areas of trade, financial matters, administration, and social sciences in common. In this manner, it was decided that the distributions found within the Scopus database can offer a respectable rundown of the writing on supply chain integration of fake insights and blockchain that's germane to this examination.

The flowchart of the strategy utilized in this paper is appeared in Figure 1. We made a list of terms within the to begin with stage of the look handle that would, to the most excellent of our capacity, include all germane distributions within the Scopus database. TITLE-ABS-KEY ("blockchain" OR "square chain") AND ("manufactured insights" OR "machine learning" OR "neural arrange" OR "deep learning") AND "supply chain" was the Scopus look algorithm. The title, unique, and watchword list of each distribution were looked for these terms. 280 archive comes about, all distributed between 2017 and 2022, were gotten from the look. Downloads of information started on Walk 27, 2022. The bibliometric analysis method was utilized to look at these records.

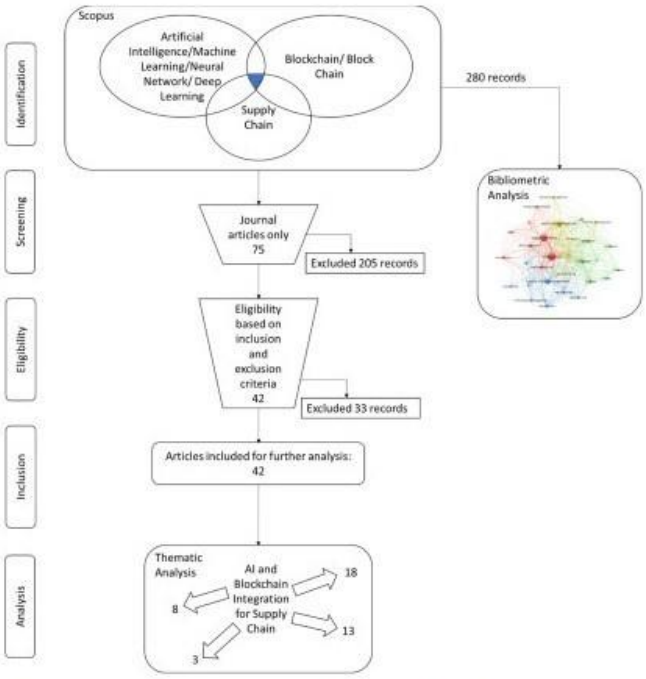

Fig. 1 Flowchart of the systematic literature review with bibliometric analysis and thematic analysis

The previously mentioned criteria were intentionally connected broadly in arrange to discover related data and give us with an thought of the current and future zones of intrigued for the field's scholastics. Moreover, a

comparatively little number of results—only 280—were returned. Be that as it may, as conference papers are ordinarily created to communicate preliminary discoveries, we thought almost overlooking them from our investigation since they are more like works in advance than wrapped up articles (Mubin et al., 2018). Since book chapters, conference audits, and surveys perform diverse assignments from diary articles and have different purposes, they were too given cautious thought. In any case, the choice was made to incorporate such fabric. The contention was that since the region is still in its earliest stages, it makes sense that more investigate is being conducted or maybe than completed which more of it is theoretical or conceptual in character as restricted to experimental. Therefore, in arrange to way better capture all proceeding investigate endeavors, it would be extraordinary at this time to supply an outline of the entirety pool of records that we came over. Utilizing the VOSviewer bibliometric analysis programme, a co-occurrence investigation was performed on the 280 information (Sect. 3.2). The 280 records were sifted within the another stage (Order. 3.3), and as it were diary papers—which are distributed, comprehensive, and subject to peer review—were chosen for extra examination. This delivered 75 investigate distributions. Taking after the advancement of a set of consideration and exclusion criteria, a manual examination of the 75 investigate articles was carried out to find out whether or not they tended to the integration of blockchain and manufactured intelligence for supply chain in a clear and concise way. After this arrange, 42 inquire about articles made up the ultimate pool, which underwent a thematic analysis.

3.2. Biblometric analysis of the results

Agreeing to Liu et al. (2011), bibliometric analysis could be a helpful think about strategy for spotting around the world investigate patterns and determining future investigate ways. This inquire about employments bibliometric examination to distinguish the highlights and designs in supply chain-related considers that combine blockchain with fake insights. Rundowns measurements are used to dissect the discoveries.

As outlined in Fig. 2, the number of articles on supply chain blockchain and AI has grown over time. It is critical to note that, at slightest concurring to the Scopus database, all 280 of the records found were distributed after 2017, suggesting that no distributions using the three watchwords had been published prior to this year. Moment, there has been a rise in intrigued within the subject matter in later a long time, cresting in 2021 (124 records).

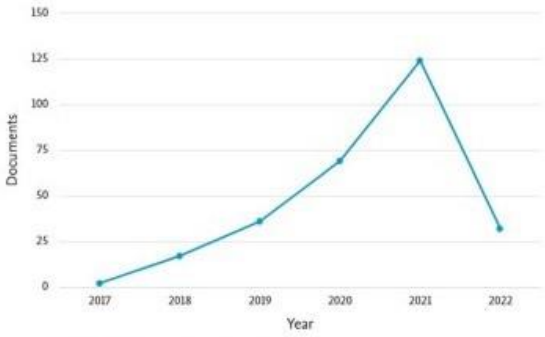

Fig. 2 Annual scientific production. (Source: Scopus 2022)

The annual report volume isolated down by data source is seen in Figure 3. IFIP Advances in Data and Communication Technology (17 reports), Progresses in Cleverly Frameworks and Computing (11 reports), Communications in Computer and Data Science (10 reports), Address Notes in Computer Science counting Subseries Address Notes in Artificial Insights and Address Notes in Bioinformatics (10 archives), and Supportability Switzerland (9 records) are the best five preferred outlets for publications on blockchain and fake insights for supply chains. The reports are arranged by alliance in Figure 4, with the primary 12 affiliations being shown in connection to the entire number of documents. With five distributions, the College of the West of England (Incredible Britain) tops the association positioning. Diminish the Extraordinary St. Petersburg Polytechnic University (Russia) and Hong Kong Polytechnic University (Hong Kong) take after closely behind with four distributions each. Each of the another nine teach delineated within the picture has three distributions. It's exceptional to observe how numerous diverse countries are spoken to in these educate.

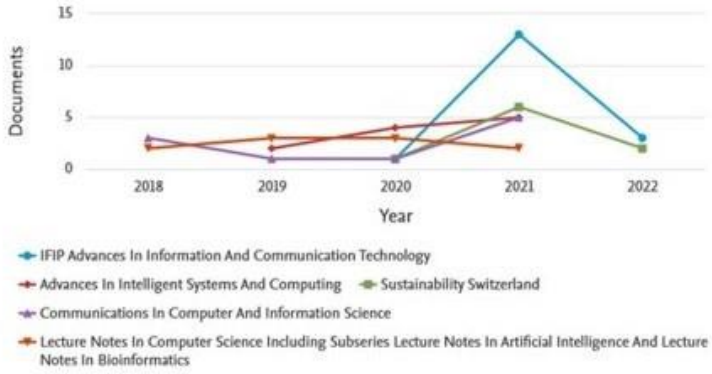

Fig. 3 Documents per year per source. (Source: Scopus 2022)

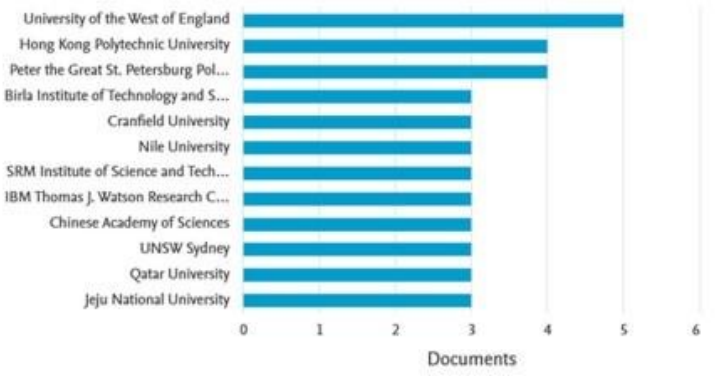

Fig. 4 Documents by affiliation (Source: Scopus 2022)

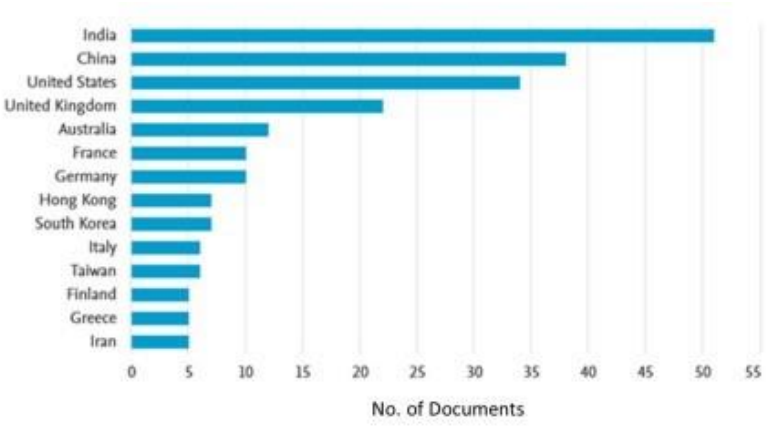

Fig. 5 Documents by country or territory. (Source: Scopus 2022)

In order to decide which 13 countries or regions have the most distributions, Figure 5 compares their archive checks. The nation of the comparing creator chosen the countries of beginning. India tops the list with 51 distributions, effortlessly taken after by the Joined together States and China with 38 and 34 distributions, separately. One essential finding is that the combined number of publications from these best three countries is over half (i.e., 44%). With 22 distributions, the Joined together Kingdom holds the fourth spot, and Australia comes in fifth with 12 publications. With ten distributions each, France and Germany come in 6th and seventh rank, respectively. South Korea and Hong Kong come in second and third, Italy and Taiwan come in 6th and seventh, whereas Finland, Greece, and Iran come in fifth and 6th put, individually. The amount of documents by distribution kind is shown in

Table 1. With respect to this, we can see that conference papers make up the larger part of the writing (86 documents add up to, or around 30% of all publications). The oddity of the investigate issue and the fact that the teach is still in its early stages may be the reasons for the wealth of conference papers in the writing. Another, there are articles (a add up to of 75 things, or around 27% of the distributions). 68 archives, or around 24% of the distributions, are conference surveys. Books and editorials contain the least number of reports (4 and 3 individually), though book chapters and reviews each have 22.

Table 1 Documents by publication type (Source: Scopus 2022)

Document type	No. of documents	%
Conference paper	86	30.71
Article	75	26.79
Conference review	68	24.29
Book chapter	22	7.86
Review	22	7.86
Book	4	1.43
Editorial	3	1.07
Total	280	100.00

Table 2 Documents by subject area (Source: Scopus 2022)

Subject area	No. of documents	%
Computer science	171	28.98
Engineering	114	19.32
Decision sciences	67	11.36
Business, management, and accounting	47	7.97
Mathematics	40	6.78
Social sciences	36	6.10
Environmental science	24	4.07
Energy	18	3.05
Physics and astronomy	13	2.20
Agricultural and biological sciences	10	1.69
Materials science	10	1.69
Chemical engineering	9	1.53
Medicine	9	1.53
Earth and planetary sciences	8	1.36
Economics, econometrics, and finance	4	0.68
Biochemistry, genetics, and molecular Biology	3	0.51
Psychology	2	0.34
Chemistry	1	0.17
Health professions	1	0.17
Immunology and microbiology	1	0.17
Nursing	1	0.17
Pharmacology, toxicology and Pharmaceutics	1	0.17
Total	590	100.00

A publication can be classified under more than one subject area

In conclusion, a think about of distributed records by subject region (Table 2) appears that, with a stunning 171 papers, or 29% of the distributions, the subject region of "computer science" centers the lion's share of the inquire about on the issue. The areas of "building," with 114 papers, or around 19% of the distributions, and "choice sciences," with 67 reports, or generally 11% of the distributions, are next in line. With 47 documents, or 8% of the publications, the fields of "trade, administration, and bookkeeping" and "social sciences" are positioned fourth and

fifth, separately. Based on bibliographic information, maps of co-authorship and catchphrase cooccurrence were delivered utilizing the VOSviewer program. At least five reports per country were needed for the co-authorship examination (Fig. 6); 14 of the 63 countries that were found to meet this requirement. Regarding this, the arrange outline of worldwide participation between expansive countries (those with the most noteworthy in general interface quality) included in supply chain investigate utilizing blockchain and manufactured insights is appeared in Fig. 6. The surface range of the circles speaks to the number of publications each nation has secured, whereas the colours speak to the clusters to which the nations are assigned based on the strength of their joins. It is obvious that there are six clusters in all.

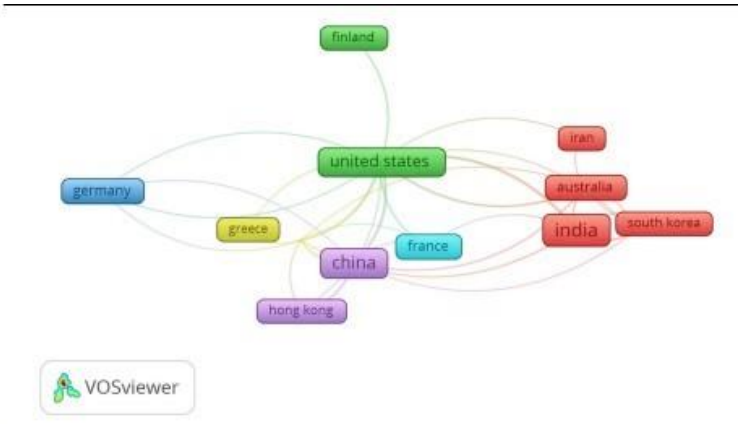

Fig. 6 Co-authorship network of countries

A catchphrase co-occurrence investigation (Fig. 7) was carried out utilizing record catchphrases as the unit of examination, a least of six events per catchphrase, and full counting as the counting strategy. 35 out of the 1210 watchwords were qualified. For every one of the 35 catchphrases, the by and large quality of the co-occurrence linkages with other terms was computed. The terms with the strongest by and large joins were our choices. Coloured frames that compare in estimate to the number of times a keyword shows up within the page are utilized to distinguish keywords.

These watchwords are further divided into four clusters: "nourishment and horticulture" (green cluster), "hazard, strength, and supportability" (blue cluster), "security and ethical administration" (ruddy cluster), and "rising advances and their benefits" (yellow cluster). These clusters show up to play a critical part in connection to each other. This illustrates the topics that analysts considering blockchain and manufactured insights for supply chains are fascinated by.

3.3. Collection of studies on the fusion of Artificial Intelligence and Blockchain

After getting a common thought of "what is out there" in terms of the body of inquire about on the subject—the 280 records secured in Faction. 3.2—we included, as already shown, a moment organize in which we advance refined our look comes about to distinguish as it were those considers that especially tended to the supply chain integration of blockchain and manufactured insights. This time, the choice was made to center exclusively on investigate articles in arrange to recognize completely distributed, peer-reviewed inquire about ventures. 75 inquire about articles were chosen for extra investigation as a result of this choice (allude to the going before Table 1). After that, the 75 investigate articles were physically inspected by the creators to find out whether or not they talked about the supply chain utilize of blockchain and fake insights.

A think about was qualified for extra examination in case it fulfilled the consequent prerequisites:

1. The articles' central questions tended to the subjects of "blockchain," "AI" (or any of its intermediaries, "machine learning," "neural arrange," or "profound learning"), and "supply chain."

2. Inquire about on the integration of blockchain and manufactured insights (AI) for supply chains was the clear accentuation of all the inquire about, notwithstanding of whether they were conceptual works, experimental, case thinks about, or writing audits.

3. Notwithstanding of the year of distribution, any investigate distributed in English was included within the thinks about.

Articles were excluded if:

1. Without any center on their integration, the subjects of "blockchain" and "AI" (or any of its intermediaries, "machine learning," "neural organize," and "profound learning") were examined freely.
2. We were incapable to affirm the substance since the whole content was inaccessible.
3. Since the diary distribution was halted, the total content was moreover inaccessible, making it incomprehensible for us to affirm the data.
4. Indeed in spite of the fact that the records were distinguished as investigate articles, it turned out that they were really publications or other shapes of distribution.
5. In spite of the fact that it was exterior the domain of our consider, the papers utilized the expressions "blockchain" and/or "AI" (or any of its intermediaries, "machine learning," "neural network," or "profound learning") to assess observational information within the setting of a supply chain.

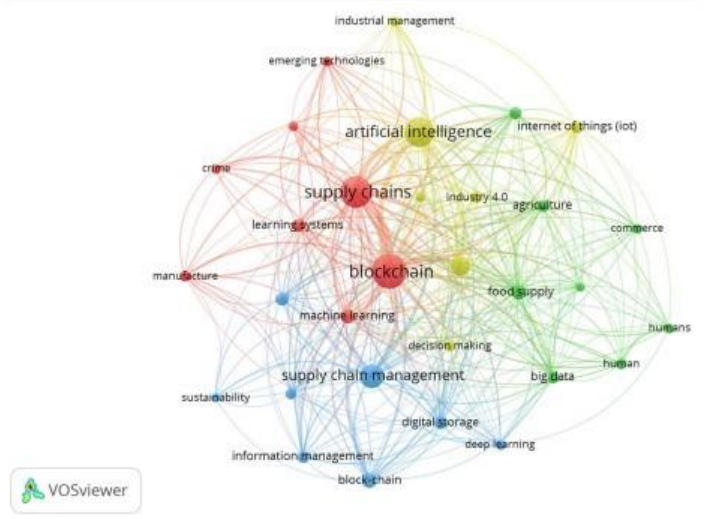

Fig. 7 Network map showing the relations between various topics in the literature on blockchain and AI for supply chain (280 documents)

4. Interpreting Clusters

4.1. Cluster 1: Food and Agriculture

Troublesome data and communication innovations, such as counterfeit insights (AI) and machine learning (ML), huge information analytics, cloud computing, the Web of Things (IoT), mechanical technology, and blockchain, can offer assistance with issues like raising abdicate and efficiency, sparing water, keeping up plant and soil wellbeing, and upgrading natural stewardship. These advances "will let the farming to advance in a data-driven, brilliantly, spry, and independent associated framework of frameworks," claim Lezoche et al. (2020). In expansion to the focal points for maintainability, AI-ML innovations in specific can improve item traceability, straightforwardness, and perceivability within the supply chain (Sharma et al., 2020a, b). All of these initiatives are still within the early stages, in this manner professionals will got to see at the potential of joining distinctive AI-ML information sources with blockchain innovation and other innovations more altogether (Kamble et al., 2018; Sharma et al., 2018). Investigate has started to surface. In arrange to lower agri-food chance and make a supply chain traceability framework, Tian (2016), for occasion, collected and shared reliable data utilizing RFID (Radio-Frequency Distinguishing proof) and Blockchain innovation. Strikingly, our appraisal demonstrated that one of the foremost prevalent investigate ventures being worked on by scholastics at the minute is making item traceability frameworks. Two fundamental blockchain employments within the rural space are keen contracts and cybersecurity.

Exact detecting is made conceivable over the supply chain through the Web of Things. Each exchange including keen contracts is distributedly recorded. Unchangeable exchange records from providers of crude materials to conclusion clients would encourage the administration of nourishment quality, progress traceability, and in the long run ease stresses almost nourishment security. It is expected that blockchain-based shrewd contract innovations would encourage the computerized change of the agri-food supply chain, creating a "traceable, straightforward, trustful, and brilliantly ecosystem" (Liu et al., 2021a, b, p. 4330).

In their intensive appraisal of the writing, Sharma et al. (2020a, b) discovered that all three machine learning algorithms—supervised, unsupervised, and support learning—are utilized to the advancement of feasible rural supply chains. The report does not, be that as it may, address how blockchain innovation and ML calculations are coordinates. Be that as it may, Putri et al. (2020) pointed out that within the future, fake insights (AI) can be used to form and execute hyperledger blockchains, which is able enable the expectation, classification, and clustering of current information and exchanges agreeing to their time period. Many thinks about, just like the one by Chen (2018), appear how blockchain and AI approaches can be successfully integrated to progress supply chain traceability, in spite of the truth that the larger part of the materials found treat the subject hypothetically. In this respect, Chen (2018) displayed a brand-new strategy for a traceability chain calculation known as the Takagi–Sugeno Fluffy cognitive maps manufactured neural organize.

4.2. Cluster 2: Risk, Resilience, and Sustainability

Over the past few a long time, supply chain disturbances have been caused by the complexity of the supply chain arrange in conjunction with exterior impacts (Fan & Stevenson, 2018). Most as of late, the widespread has brought supportability back into the open eye. In reality, the COVID-19 scourge in early 2020 has brought attention to supply chain powerlessness more than any other later event (Pournader et al., 2020; Spieske & Birkel, 2021). The supply chain for pharmaceuticals, in specific, has been essentially affected within the therapeutic field. The fast appearance and unchecked worldwide spread of COVID-19 has uncovered the deficiencies of the existing healthcare systems worldwide in terms of instantly responding to public wellbeing crises. In such cases, cutting-edge innovations like blockchain and manufactured insights (AI) have appeared guarantee as long-term, workable means of containing the widespread (Baz et al., 2021). This has driven to a common zone of inquire about that has as of late attracted the consideration of researchers. Inside this system, ponders looking at the administration of the pharmaceutical, restorative, and sedate supply chains have surfaced.

The current healthcare frameworks may be strained by the COVID-19 widespread. There's as of now a need of a reliable information observation framework that can donate germane healthcare bunches up-to-date data with respect to conceivable flare-ups. In truth, a huge sum of wrong data that has not been carefully verified may be found within the larger part of the current Covid-19 information, which comes from a assortment of sources such as the common populace, hospitals, and clinical research facilities (Nguyen et al., 2021). By encouraging early flare-up discovery, ensuring a secure pharmaceutical supply chain and speeding medicate conveyance, and making agreement on the requesting of Covid-19 information records, blockchain innovation can offer assistance combat the COVID-19 widespread (Baz et al., 2021). Moreover, the creation of shrewdly arrangements for widespread drift determining, coronavirus symptom location for treatment, real-time epidemic outbreak monitoring, and sedate fabricating bolster is made conceivable by AI-based directed and unsupervised ML techniques.

Computer programs that execute a contract's terms when particular objectives are met are known as blockchain-based shrewd contracts (Griggs et al., 2018). Savvy contracts built on blockchain innovation may be used to computerize restorative supply chain administration, flare-up following, inaccessible understanding checking, and examining strategies (Griggs et al., 2018; Roosan et al., 2022). Pharmaceutical supply chains may be made way better, their quality and administrative compliance can be affirmed, and examining strategies can be robotized with the utilize of blockchain-based keen contracts (Angeles, 2018). Blockchain and AI innovation integration could change the patient-centered approach to healthcare (Chen et al., 2019; Jabarulla & Lee, 2021; Ploug & Holm, 2020). Appropriately, it's doable that treating the coronavirus pandemic from a patient-centered point of view will offer assistance with treatment conveyance and widespread administration (Jabarulla & Lee, 2021). A comprehensive prescient framework that might help in containing the threat of a widespread interior a nation's borders has been created much obliged to the integration of blockchain and manufactured intelligence technology (Fusco et al., 2020). Moreover, blockchain innovation, artificial intelligence, and geographic data frameworks can be combined to reinforce and move forward the open reconnaissance framework (Sharma et al., 2020a, b). An other range of

research that's picking up footing is the application of blockchain-AI integration for supportability and the circular economy. More verification of the progressions being made in this field comes from ponders just like the one distributed by Ebinger and Omondi (2020) on the application of computerized advances (counting blockchain, cloud computing, and AI) in feasible supply chain management. Pimenidis et al. (2021) have proposed a supply chain community that's cleverly, responsive, secure, and economical, upheld by an cleverly operator and empowered by blockchain innovation. Agreeing to Chidepatil et al. (2020), multi-sensor AI and blockchain have the potential to change the circular economy of plastic trash. Sivarethinamohan and Sujatha (2021) examined the potential applications of AI-driven blockchain innovation within the guard and conservation of the worldwide environment, including underground life, earthbound life, and climate alter.

4.3. Cluster 3: Security and Ethical Governance

The need for made strides privacy and security, particularly with respect to users' individual information, has been brought to light by later spikes in security breaches and advanced observation (Heister & Yuthas, 2021). Imaginative techniques for shielding client information by means of decentralised identification and extra security shields are made conceivable by blockchain innovations. By giving consumers the means to control and manage their data, these platforms can enable their clients. Be that as it may, AI makes unused openings for improving client and framework security. As Heister and Yuthas (2021) point out, “Blockchain offers new mechanisms such as: “For example, decentralized identities and zero-knowledge proofs ensure personal security and It allows you to exchange information in a way that allows you to maintain control of your data.” These progresses can give both increased cybersecurity and more moral utilize of individual information. Blockchain members can realize these results through cautious improvement of administration systems and mechanisms”. Hence, modern openings for the ethical application of information are created by the advancements in these innovations. Furthermore, blockchain can improve the capabilities of other advances and methodologies, such AI and IoT in-process observing, drift forecast, and decision-making, among others, by upgrading the quality, transparency, traceability, and security of information (Sun & Zhang, 2020). Supply chains, counterfeit insights, and blockchain innovation may improve information administration for organized gadgets. Unal et al. (2021) has distributed a report sketching out a workable procedure for combined learning and blockchain integration to empower the arrangement of private and secure enormous information analytics services.

Data management is one of the most factors influencing supply chains to use blockchain and AI. Blockchain innovation can be utilized by supply chains to arrange a tried and true and secure advanced move, indeed digitizing each aspect of their trade. Regulatory advantages including time savings, better data quality, and higher security can be gotten by integrating blockchain and AI into data administration operations. Current research ventures are centering on all of these developments.

4.4. Cluster 4: Emerging Technologies and their benefits

Industry 4.0 components such as blockchain, fake insights, cloud computing, Web of Things, robots, and cyber-physical frameworks are cases of later specialized changes that make it conceivable to combine different supply chain developments into brilliantly and organized Frameworks of Frameworks. These advances will offer assistance the pertinent divisions gotten to be more data-driven, adaptable, cleverly, and robotized. They can moreover make strides supply chain administration. For illustration, Rodríguez-Espíndola et al. (2020) fought that the compassionate supply chain cannot succeed until diverse advances are coordinates. In arrange to realize this, the creators put up a worldview for coordination three troublesome rising technologies—blockchain, manufactured insights, and 3D printing—to progress the stream of data, merchandise, and monetary assets in helpful supply chains. Their investigate appears that the system can ease supply chain clog, upgrade concurrent participation between diverse partners, abbreviate lead times, and upgrade responsibility, traceability, and straightforwardness of fabric and budgetary assets. It can too empower casualties to require portion in assembly their possess needs. Later advancements in these regions propose that frameworks with tall information keenness and client privacy—which blockchain innovation alone can provide—may be vital for the selection of shrewd gadgets based on the Web of

Things and other advances (Chanson et al., 2019). Besides, supply chains can endeavor towards getting to be "keen supply chains" by melding blockchain innovation and AI with IoT sensors and edge gadgets.

Also, these advances empower cleverly transportation frameworks. In expansion to coordination blockchain wallets that let clients pay for rides, rentals, tolls, and other administrations without uncovering individual data, self-driving cars can moreover use IoT sensors to ceaselessly screen and, in a few circumstances, expect improvements utilizing AI (Heister & Yuthas, 2021).

5. Future Research Directions

There is a great deal of potential for future research into supply chain applications that combine blockchain technology with artificial intelligence (AI). This combination can have a big effect in the following areas:

1. **Efficiency and Transparency:** Supply chain operations can be streamlined to become more transparent and efficient by integrating blockchain technology. Blockchain-based smart contracts can automate processes such as quality control, payments, and inventory management, minimising errors and lowering the need for human interaction.
2. **Provenance and Traceability:** Businesses may monitor products from raw ingredients to the finished product by using blockchain's unchangeable record, which facilitates end-to-end product traceability. By analysing this data, AI systems may offer insights into the supply chain, including locating bottlenecks, planning the best routes, and guaranteeing legal compliance.
3. **Risk management:** In real time, supply chain risks like as disruptions from weather-related catastrophes, geopolitical conflicts, or supplier failures can be evaluated using AI-powered analytics. Businesses can prevent hazards and create more robust supply chains by fusing blockchain's secure data storage with AI's predictive powers.
4. **Prevention of Counterfeiting:** By giving objects distinct digital identities, blockchain technology makes it harder for thieves to copy or tamper with merchandise. Artificial intelligence (AI) algorithms are capable of analysing data from these digital identities to find irregularities that can point to supply chain fraud.
5. **Sustainability:** By offering transparent data on environmental effect along the entire supply chain, blockchain and AI integration can help with sustainability initiatives. Utilising this data will optimise resource utilisation, cut waste, and guarantee adherence to sustainability guidelines.
6. **Collaboration and Trust:** By enabling safe data exchange and cooperation amongst supply chain participants, blockchain builds business partnerships' trust and lowers friction. AI is capable of analysing shared data to find areas of cooperation, optimise inventory levels, and enhance supply chain efficiency as a whole.
7. **Personalised Experiences:** Businesses may provide clients with customised packing options, real-time order tracking, and product recommendations that are specifically catered to their interests by utilising blockchain data and artificial intelligence.

All things considered, supply chain applications using blockchain technology and AI present numerous chances to improve productivity, openness, sustainability, and consumer experiences down the road. Future developments in supply chain management techniques should be anticipated as these technologies continue to advance.

6. Conclusion

The speed at which blockchain- and AI-based thoughts are being grasped cannot be debated. In spite of the fact that both ideal models give something novel, there are critical contrasts in terms of imagination and complexity. Given the far reaching utilization of advanced money in cutting edge culture, blockchain innovation has the potential to robotize installments and empower the secure, disseminated exchange of exchange records and delicate information. AI and blockchain innovation have both picked up consideration of late. Blockchain innovation employments a decentralised, secure, and solid framework to computerize bitcoin installments and give clients with get to to a shared record of records, exchanges, and information. Keen contracts in blockchain innovation may be able to control client intuitive without the require for a central specialist. Alternately, counterfeit insights (AI) invests machines with human-level thinking and decision-making capacities. Combining these two innovations, in

spite of the fact that, might definitely modify the showcase. Indeed in spite of the fact that both innovations are cutting edge, blending them may permit for faster and less demanding work completion. This understanding provoked an broad assessment of articles combining blockchain innovation with counterfeit insights that were distributed between 2012 and 2022. This conversation looked at the state of blockchain and AI advances nowadays, their employments, and the potential progressive impacts of their uncommon qualities. In add up to, 121 different articles on the subject were taken under consideration for this assessment. The acknowledgment of the conceivable outcomes of blockchain innovation and manufactured insights is developing. This paper talks about the points of interest of combining blockchain innovation with manufactured insights. The application cases for integration—which incorporate supply chains, monetary administrations, healthcare, life sciences, keen networks, farming, and the Web of vehicles—take up the lion's share of this examination. Prior to drawing to a near, subjects such as security and security, dependable prophets, keen contract security and the impacts of its deterministic execution, versatility, and participation between off-chain and on-chain information capacity were examined.

7. References

1. Baynham-Herd, Z. Enlist blockchain to boost conservation. Nature 2017, 548, 523. [CrossRef] [PubMed]
2. Maxmen, A. AI researchers embrace Bitcoin technology to share medical data. Nature 2018, 555, 293–295. [CrossRef]
3. Nakamoto, S. Bitcoin: A Peer-to-Peer Electronic Cash System; 2009. Available online: https://bitcoin.org/bitcoin.pdf (accessed on 1 October 2022).
4. Taherdoost, H. An Overview of Trends in Information Systems: Emerging Technologies that Transform the Information Technology Industry. Cloud Comput. Data Sci. 2022, 4, 1–16. [CrossRef]
5. Moosavi, N.; Taherdoost, H. Blockchain and Internet of Things (IoT): A Disruptive Integration. In Proceedings of the 2nd International Conference on Emerging Technologies and Intelligent Systems (ICETIS 2022), Virtual Conference, 2–3 September 2022; Lecture Notes in Networks and Systems. Springer: Berlin/Heidelberg, Germany, 2022.
6. Swan, M. Blockchain: Blueprint for a New Economy; O'Reilly Media, Inc.: Sebastopol, CA, USA, 2015.
7. Pandl, K.D.; Thiebes, S.; Schmidt-Kraepelin, M.; Sunyaev, A. On the convergence of artificial intelligence and distributed ledger technology: A scoping review and future research agenda. IEEE Access 2020, 8, 57075–57095. [CrossRef]
8. Lin, J.; Shen, Z.; Miao, C. Using blockchain technology to build trust in sharing LoRaWAN IoT. In Proceedings of the 2nd International Conference on Crowd Science and Engineering, Beijing, China, 6–9 July 2017; pp. 38–43.
9. Dai, Y.; Xu, D.; Maharjan, S.; Chen, Z.; He, Q.; Zhang, Y. Blockchain and deep reinforcement learning empowered intelligent 5G beyond. IEEE Netw. 2019, 33, 10–17. [CrossRef]
10. Salimitari, M.; Chatterjee, M.; Yuksel, M.; Pasiliao, E. Profit maximization for bitcoin pool mining: A prospect theoretic approach. In Proceedings of the 2017 IEEE 3rd International Conference on Collaboration and Internet Computing (CIC), San Jose, CA, USA, 15–17 October 2017; pp. 267–274.
11. Singh, S.K.; Rathore, S.; Park, J.H. Blockiotintelligence: A blockchain-enabled intelligent IoT architecture with artificial intelligence. Future Gener. Comput. Syst. 2020, 110, 721–743. [CrossRef]
12. Dinh, T.N.; Thai, M.T. AI and blockchain: A disruptive integration. Computer 2018, 51, 48–53. [CrossRef]
13. Taherdoost, H. A Critical Review of Blockchain Acceptance Models—Blockchain Technology Adoption Frameworks and Applications. Computers 2022, 11, 24. [CrossRef]
14. Wood, G. Ethereum: A secure decentralised generalised transaction ledger. Ethereum Project Yellow Paper 2014, 151, 1–32.
15. Kumar, A.; Abhishek, K.; Nerurkar, P.; Ghalib, M.R.; Shankar, A.; Cheng, X. Secure smart contracts for cloud-based manufacturing using Ethereum blockchain. Trans. Emerg. Telecommun. Technol. 2022, 33, e4129. [CrossRef]
16. Li, D.; Deng, L.; Cai, Z.; Souri, A. Blockchain as a service models in the Internet of Things management: Systematic review. Trans. Emerg. Telecommun. Technol. 2022, 33, e4139. [CrossRef]
17. Wang, S.; Yuan, Y.; Wang, X.; Li, J.; Qin, R.; Wang, F.-Y. An overview of smart contract: Architecture, applications, and future trends. In Proceedings of the 2018 IEEE Intelligent Vehicles Symposium (IV), Changshu, China, 26–30 June 2018; pp. 108–113.

18. Makarius, E.E.; Mukherjee, D.; Fox, J.D.; Fox, A.K. Rising with the machines: A sociotechnical framework for bringing artificial intelligence into the organization. J. Bus. Res. 2020, 120, 262–273. [CrossRef]

19. Fusco, A.; Dicuonzo, G.; Dell'Atti, V.; Tatullo, M. Blockchain in healthcare: Insights on COVID-19. Int. J. Environ. Res. Public Health 2020, 17, 7167. [CrossRef] [PubMed]

20. Daley, S. Tastier Coffee, Hurricane Prediction and Fighting the Opioid Crisis: 31 Ways Blockchain and AI Make a Powerful Pair. Builtin in April, 2020. Available online: https://builtin.com/artificial-intelligence/blockchain-ai-examples (accessed on 1 October 2022).

21. Soleymani, F.; Paquet, E. Financial portfolio optimization with online deep reinforcement learning and restricted stacked autoencoder—DeepBreath. Expert Syst. Appl. 2020, 156, 113456. [CrossRef]

22. Moosavi, N.; Taherdoost, H. Blockchain-Enabled Network for 6G Wireless Communication Systems. In Proceedings of the International Conference on Intelligent Cyber Physical Systems and Internet of Things (ICoICI 2022), Coimbatore, India, 11–12 August 2022; Engineering Cyber-Physical Systems and Critical Infrastructures. Springer: Berlin/Heidelberg, Germany, 2022.

23. Parizi, R.M.; Dehghantanha, A. Smart contract programming languages on blockchains: An empirical evaluation of usability and security. In Proceedings of the International Conference on Blockchain, Halifax, NS, Canada, 30 July–3 August 2018; Springer: Berlin/Heidelberg, Germany, 2018; pp. 75–91.

24. Parizi, R.M.; Dehghantanha, A.; Choo, K.-K.R.; Singh, A. Empirical vulnerability analysis of automated smart contracts security testing on blockchains. arXiv 2018, arXiv:1809.02702.

25. Rabah, K. Convergence of AI, IoT, big data and blockchain: A review. Lake Inst. J. 2018, 1, 1–18.

26. Chamola, V.; Hassija, V.; Gupta, V.; Guizani, M. A comprehensive review of the COVID-19 pandemic and the role of IoT, drones, AI, blockchain, and 5G in managing its impact. IEEE Access 2020, 8, 90225–90265. [CrossRef]

27. Salah, K.; Rehman, M.H.U.; Nizamuddin, N.; Al-Fuqaha, A. Blockchain for AI: Review and open research challenges. IEEE Access 2019, 7, 10127–10149. [CrossRef]

28. Mamoshina, P.; Ojomoko, L.; Yanovich, Y.; Ostrovski, A.; Botezatu, A.; Prikhodko, P.; Izumchenko, E.; Aliper, A.; Romantsov, K.; Zhebrak, A. Converging blockchain and next-generation artificial intelligence technologies to decentralize and accelerate biomedical research and healthcare. Oncotarget 2018, 9, 5665. [CrossRef]

29. Singh, S.; Sharma, P.K.; Yoon, B.; Shojafar, M.; Cho, G.H.; Ra, I.-H. Convergence of blockchain and artificial intelligence in IoT network for the sustainable smart city. Sustain. Cities Soc. 2020, 63, 102364. [CrossRef]

30. Lin, X.; Li, J.; Wu, J.; Liang, H.; Yang, W. Making knowledge tradable in edge-AI enabled IoT: A consortium blockchain-based efficient and incentive approach. IEEE Trans. Ind. Inform. 2019, 15, 6367–6378. [CrossRef]

31. Rodríguez-Espíndola, O.; Chowdhury, S.; Beltagui, A.; Albores, P. The potential of emergent disruptive technologies for humanitarian supply chains: The integration of blockchain, Artificial Intelligence and 3D printing. Int. J. Prod. Res. 2020, 58, 4610–4630. [CrossRef]

32. Kumari, A.; Gupta, R.; Tanwar, S.; Kumar, N. Blockchain and AI amalgamation for energy cloud management: Challenges, solutions, and future directions. J. Parallel Distrib. Comput. 2020, 143, 148–166. [CrossRef]

33. Akter, S.; Michael, K.; Uddin, M.R.; McCarthy, G.; Rahman, M. Transforming business using digital innovations: The application of AI, blockchain, cloud and data analytics. Ann. Oper. Res. 2020, 308, 7–39. [CrossRef]

34. Chidepatil, A.; Bindra, P.; Kulkarni, D.; Qazi, M.; Kshirsagar, M.; Sankaran, K. From trash to cash: How blockchain and multi-sensor-driven artificial intelligence can transform circular economy of plastic waste? Adm. Sci. 2020, 10, 23. [CrossRef]

35. Rajagopal, B.R.; Anjanadevi, B.; Tahreem, M.; Kumar, S.; Debnath, M.; Tongkachok, K. Comparative Analysis of Blockchain Technology and Artificial Intelligence and Its Impact on Open Issues of Automation in Workplace. In Proceedings of the 2022 2nd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE), Greater Noida, India, 28–29 April 2022; pp. 288–292.

36. Lopes, V.; Alexandre, L.A.; Pereira, N. Controlling robots using artificial intelligence and a consortium blockchain. arXiv 2019, arXiv:1903.00660.

37. Li, W.; Su, Z.; Li, R.; Zhang, K.; Wang, Y. Blockchain-based data security for artificial intelligence applications in 6G networks. IEEE Netw. 2020, 34, 31–37. [CrossRef]

38. Bonifazi, G.; Corradini, E.; Ursino, D.; Virgili, L. A social network analysis–based approach to investigate user behaviour during a cryptocurrency speculative bubble. J. Inf. Sci. 2021. [CrossRef]

39. Indu, V.; Thampi, S.M. A systematic review on the influence of User personality in rumor and misinformation propagation through social networks. In Proceedings of the International Symposium on Signal Processing and Intelligent Recognition Systems, Online, 29–30 December 2021; Springer: Berlin/Heidelberg, Germany, 2021; pp. 216–242.

40. Golbeck, J.; Robles, C.; Turner, K. Predicting personality with social media. In CHI'11 Extended Abstracts on Human Factors in Computing Systems; Association for Computing Machinery: New York, NY, USA, 2011; pp. 253–262.

41. Meng, W.; Li, W.; Zhu, L. Enhancing medical smartphone networks via blockchain-based trust management against insider attacks. IEEE Trans. Eng. Manag. 2019, 67, 1377–1386. [CrossRef]

42. He, S.; Zhang, Y.; Zhu, R.; Tian, W. Electric signature detection and analysis for power equipment failure monitoring in smart grid. IEEE Trans. Ind. Inform. 2020, 17, 3739–3750. [CrossRef]

43. He, S.; Tian, W.; Zhang, J.; Li, K.; Zhang, M.; Zhu, R. A high efficient approach for power disturbance waveform compression in the view of heisenberg uncertainty. IEEE Trans. Ind. Inform. 2018, 15, 2580–2591. [CrossRef]

44. Mollah, M.B.; Zhao, J.; Niyato, D.; Lam, K.-Y.; Zhang, X.; Ghias, A.M.; Koh, L.H.; Yang, L. Blockchain for future smart grid: A comprehensive survey. IEEE Internet Things J. 2020, 8, 18–43. [CrossRef]

45. Cadoret, D.; Kailas, T.; Velmovitsky, P.; Morita, P.; Igboeli, O. Proposed implementation of blockchain in british columbia's health care data management. J. Med. Internet Res. 2020, 22, e20897. [CrossRef] [PubMed]

46. Aderibole, A.; Aljarwan, A.; Rehman, M.H.U.; Zeineldin, H.H.; Mezher, T.; Salah, K.; Damiani, E.; Svetinovic, D. Blockchain technology for smart grids: Decentralized NIST conceptual model. IEEE Access 2020, 8, 43177–43190. [CrossRef]

47. Wang, Z.; Ogbodo, M.; Huang, H.; Qiu, C.; Hisada, M.; Abdallah, A.B. AEBIS: AI-enabled blockchain-based electric vehicle integration system for power management in smart grid platform. IEEE Access 2020, 8, 226409–226421. [CrossRef]

48. Ge, L.; Brewster, C.; Spek, J.; Smeenk, A.; Top, J.; van Diepen, F.; Klaase, B.; Graumans, C.; de Wildt, M.D.R. Blockchain for Agriculture and Food: Findings from the Pilot Study; Wageningen Economic Research: Wageningen, The Netherlands, 2017.

49. Kamble, S.S.; Gunasekaran, A.; Gawankar, S.A. Achieving sustainable performance in a data-driven agriculture supply chain: A review for research and applications. Int. J. Prod. Econ. 2020, 219, 179–194. [CrossRef]

50. Insights, C. How Blockchain Could Transform Food Safety; 2017. Available online: https://www.cbinsights.com/research/ blockchain-grocery-supply-chain/ (accessed on 1 November 2022).

51. De Clercq, M.; Vats, A.; Biel, A. Agriculture 4.0: The future of farming technology. In Proceedings of the World Government Summit, Dubai, United Arab Emirates, 11–13 February 2018; pp. 11–13.

52. Lezoche, M.; Hernandez, J.E.; Díaz, M.D.M.E.A.; Panetto, H.; Kacprzyk, J. Agri-food 4.0: A survey of the supply chains and technologies for the future agriculture. Comput. Ind. 2020, 117, 103187. [CrossRef]

53. Khan, P.W.; Byun, Y.-C.; Park, N. IoT-blockchain enabled optimized provenance system for food industry 4.0 using advanceddeep learning. Sensors 2020, 20, 2990. [CrossRef] [PubMed]

54. Wu, H.; Cao, J.; Yang, Y.; Tung, C.L.; Jiang, S.; Tang, B.; Liu, Y.; Wang, X.; Deng, Y. Data management in supply chain using blockchain: Challenges and a case study. In Proceedings of the 2019 28th International Conference on Computer Communication and Networks (ICCCN), Valencia, Spain, 29 July–1 August 2019; pp. 1–8.

55. Liu, L.; Zhang, J.Z.; He, W.; Li, W. Mitigating information asymmetry in inventory pledge financing through the Internet of things and blockchain. J. Enterp. Inf. Manag. 2021, 34, 1429–1451. [CrossRef]

56. Gohil, D.; Thakker, S.V. Blockchain-integrated technologies for solving supply chain challenges. Modern Supply Chain Res. Appl.2021, 3, 78–97. [CrossRef]

57. D'souza, S.; Nazareth, D.; Vaz, C.; Shetty, M. Blockchain and AI in Pharmaceutical Supply Chain. In Proceedings of the International Conference on Smart Data Intelligence (ICSMDI 2021), Tamil Nadu, India, 29–30 April 2021.

58. Du, J.; Yu, F.R.; Chu, X.; Feng, J.; Lu, G. Computation offloading and resource allocation in vehicular networks based on dual-side cost minimization. IEEE Trans. Veh. Technol. 2018, 68, 1079–1092. [CrossRef]

59. Dua, A.; Kumar, N.; Das, A.K.; Susilo, W. Secure message communication protocol among vehicles in smart city. IEEE Trans. Veh. Technol. 2017, 67, 4359–4373. [CrossRef]

60. Liu, L.; Chen, C.; Pei, Q.; Maharjan, S.; Zhang, Y. Vehicular edge computing and networking: A survey. Mobile Netw. Appl. 2021, 26, 1145–1168. [CrossRef]

61. Mollah, M.B.; Azad, M.A.K.; Vasilakos, A. Secure data sharing and searching at the edge of cloud-assisted internet of things. IEEE Cloud Comput. 2017, 4, 34–42. [CrossRef]

62. Nguyen, D.C.; Pathirana, P.N.; Ding, M.; Seneviratne, A. Blockchain for 5G and beyond networks: A state of the art survey. J. Netw. Comput. Appl. 2020, 166, 102693. [CrossRef]

63. Chai, H.; Leng, S.; Chen, Y.; Zhang, K. A hierarchical blockchain-enabled federated learning algorithm for knowledge sharing in internet of vehicles. IEEE Trans. Intell. Transp. Syst. 2020, 22, 3975–3986. [CrossRef]

64. Ghosh, A.; Mistri, B. Spatial disparities in the provision of rural health facilities: Application of GIS based modelling in rural Birbhum, India. Spat. Inf. Res. 2020, 28, 655–668. [CrossRef]

65. Bell, L.; Buchanan, W.J.; Cameron, J.; Lo, O. Applications of blockchain within healthcare. Blockchain Healthc. Today 2018, 1, 1–7. [CrossRef]

66. Lin, W.-C.; Chen, J.S.; Chiang, M.F.; Hribar, M.R. Applications of artificial intelligence to electronic health record data in ophthalmology. Transl. Vis. Sci. Technol. 2020, 9, 13. [CrossRef]

67. Roehrs, A.; Da Costa, C.A.; da Rosa Righi, R.; De Oliveira, K.S.F. Personal health records: A systematic literature review. J. Med. Internet Res. 2017, 19, e5876. [CrossRef]

68. Ellingsen, G.; Hertzum, M. User requirements meet large-scale EHR suites: Norwegian preparations for Epic. Stud. Health Technol. Inform. 2020, 270, 703–707. [PubMed]

69. Al-Shawwa, B.; Glynn, E.; Hoffman, M.A.; Ehsan, Z.; Ingram, D.G. Outpatient health care utilization for sleep disorders in the Cerner Health Facts database. J. Clin. Sleep Med. 2021, 17, 203–209. [CrossRef] [PubMed]

70. Dlamini, Z.; Francies, F.Z.; Hull, R.; Marima, R. Artificial intelligence (AI) and big data in cancer and precision oncology. Comput. Struct. Biotechnol. J. 2020, 18, 2300–2311. [CrossRef] [PubMed]

71. Peterson, K.; Deeduvanu, R.; Kanjamala, P.; Boles, K. A Blockchain-Based Approach to Health Information Exchange Networks. 2016. Available online: https://www.healthit.gov/sites/default/files/12-55-blockchain-based-approach-final.pdf (accessed on 5 September 2019).

72. Kuo, T.-T.; Ohno-Machado, L. Modelchain: Decentralized privacy-preserving healthcare predictive modeling framework on private blockchain networks. arXiv 2018, arXiv:1802.01746.